Norit Activated Carbon
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INFORMATION SHEET

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rev 3

Standard Activated Carbon Injection System Specification

I. SCOPE OF WORK

A. GENERAL SCOPE OF WORK

1. PAC System Supplier.

a. The Powdered Activated Carbon (PAC) System Supplier (Seller) shall design, procure, and provide a complete, fully functional system for receiving PAC from a bulk truck transport trailer, storing PAC in a bulk dry silo and feeding PAC on demand to the battery limits indicated on the drawings. Seller shall assist with erection and installation, check out and start-up as described herein.

b. The PAC storage and dosing system shall include a PAC storage silo, silo vent filter, feeder skid, manual valves, rotary valves and instruments as required to provide a complete operating system, except as noted herein.

c. The PAC system feed skid shall be pre-assembled at the factory and delivered to the site ready for installation. The silo vent filter shall be assembled to the extent practical prior to delivery to the site.

d. Seller shall provide the silo anchor bolts and the design loads for foundation design.

e. All PAC system components shall be located inside the silo under-skirt area, mounted on the silo exterior walls or on the storage silo top deck.

f. Provide logic diagrams that will allow the Purchaser to program control of the PAC dosing system.

2. Purchaser/Installation Contractor.

a. Install the following components that are located on the silo roof or are connected to the silo including but not limited to the vent filter, level switches, electric heater, exhaust fan, interior and exterior lights and switches, level transmitter, relief valve, fill piping and supports, ladder, rest platform, roof handrail, compressed and fluidizing air piping and tubing, knife gate valve, rotary valve and expansion joint.

b. Final field assembly, field interconnecting piping, conduit and cable, field electrical and mechanical terminations, and adjustments necessary to provide a complete operating system.

c. Design and install the PAC storage silo foundation based on anchor bolt loads provided by Seller.

d. Provide all system controls via the facility DCS, conduit and wiring between DCS and system devices.

e. Provide breakers and motor starters for all 480 volt three (3) phase loads via a local motor control center, conduit and wiring between MCC and field devices and DCS.

f. Provide breakers for 120 volt, single (1) phase, 60 Hz electrical power supply to the lights and convenience receptacles from a local lighting panel, conduit and wiring between lighting panel and field devices.

g. Provide PAC transport piping from the battery limits to the Purchaser's point of usage.

h. Provide 10 scfm of dry compressed air at 100 psig to the battery limits.

B. DESIGN PARAMETERS

1. The system shall be designed to meet the following requirements:

a.	Location:	*(Purchaser to specify)*
b.	Maximum Height Limitation:	*(Purchaser to specify)*
c.	Maximum Silo Diameter:	14 feet.
d.	Vent Filter Cartridge Filter Area:	1000 square feet.
e.	Maximum System PAC Feed Rate:	*(Purchaser to specify)*
f.	Minimum System PAC Feed Rate:	*(Purchaser to specify).*
g.	PAC Injection Point Pressure:	*(Purchaser to specify).*
h.	Piping distance to PAC Injection Point	*(Purchaser to specify).*
i.	Number of LR Elbows in PAC Pipeline	*(Purchaser to specify).*
j.	Elevation change to Injection Point	*(Purchaser to specify).*

2. The system shall be designed to meet all federal, state and local codes and standards.

3. The system shall be designed in accordance with specific codes and standards referenced within these Specifications.

4. The system shall be designed to meet electrical hazard classification Class II Division 2 Group F.

C. PAC SYSTEM SUPPLIER

1. The intent of this Specification is to procure a complete PAC dosing system as described herein and as shown on the Drawings completely designed and furnished by one (1) System Supplier.

2. The System Supplier shall have a minimum verifiable history of ten (10) years of experience in the design and manufacture of PAC dosing systems and shall provide a list of similar project references.

3. Systems other than those designed specifically for use exclusively with Powdered Activated Carbon shall not be acceptable.

4. The System Supplier shall be NORIT Americas Inc. Marshall, Texas. No Substitution permitted.

D. SUBMITTALS

1. The System Supplier (Seller) shall submit the following for review by the Engineer/Purchaser prior to beginning physical work on the project:

   a. A complete set of design drawings, including, but not limited to, piping & instrument diagram, general arrangement drawings, anchor bolt location drawings, equipment location drawings, electrical wiring schematics, logic diagrams and cable raceway schematics.

   b. A written system description that describes the proposed equipment, description of operation, start-up and operating instructions, and alarms and interlocks.

   c. A complete bill of material and a product data sheets for each proposed piece of equipment.

2. The submittal shall be provided as a single document, with identifying cover sheet, table of contents, and individual sections for the different pieces of equipment. The document may be bound in a three (3) ring binder. Documents shall be no smaller than 8½" x 11", except that design drawings shall be no smaller than 11" x 17".

3. Operation and maintenance manuals shall be furnished in accordance with the requirements of Section *(Purchaser to specify)* of these Specifications.

E. STORAGE AND PROTECTION

Equipment shall be delivered to the site in the minimum shipments practical and shall be stored and protected in accordance with the Seller's recommendations and these Specifications.

F. FUNCTIONAL TEST

After the equipment has been installed and commissioned by the Installation Contractor, the Purchaser shall perform a functional test, consisting of operating the equipment continuously for five (5) each 24 hour days, to demonstrate that the equipment operates as specified.

G. SYSTEM SUPPLIER'S SERVICES

1. The PAC System Supplier shall furnish the services of a factory representative as required to support installation, checkout, start-up, functional testing and training as a part of the fixed firm price as described below. The factory representative shall have full knowledge and experience in the installation, operation, start up and maintenance requirements of the type of equipment being installed.

   a. One (1) trip to the site for a period of five (5) each 8-hour days for the purpose of supporting the Installing Contractor during the erection phase of the project.

   b. One (1) trip to the site for a period of five (5) each 8-hour days for the purpose of supporting checkout, start-up and functional testing.

   c. One (1) trip to the site for a period of two (2) each 8-hour days for the purpose of training maintenance and operations personnel in the start-up, maintenance and operation of the system.

2. The PAC System Supplier shall furnish the services of a factory representative as required to correct any PAC dosing system deficiencies that are the responsibility of the PAC System Supplier. Such trips to the site shall be at the sole expense of the Seller.

H. WARRANTY

The Seller shall warrant the equipment against defective material and workmanship for a period of one (1) year from the completion of functional testing, not to exceed eighteen (18) months from the time of delivery of the equipment.

II. GENERAL SYSTEM DESCRIPTION

A. UNLOADING AND STORAGE

Dry PAC shall be pneumatically unloaded from a bulk truck transport trailer, utilizing the truck's compressor and hoses to transport the PAC through a carbon steel pipeline tangentially into the PAC storage silo. The PAC shall be stored in a welded carbon steel silo until utilized.

B. FEEDING

A combination of specially designed air fluidization nozzles, located in the conical discharge section of the silo, shall pulse compressed air into the bulk of the carbon, promoting mass flow from the flanged discharge connection. The fluidized PAC shall be fed from the silo into a volumetric feeder hopper by a rotary valve, where it shall be temporarily stored until conveyed by the feeder discharge screw into the a drop tube and eductor inlet. The speed of the screw shall be directly proportional to the amount of carbon dropped into the drop tube/eductor. A variable speed motor shall be used to provide a wide range of carbon delivery rates from the screw.

C. TRANSPORTING

Compressed air shall be utilized for transporting the PAC from the PAC feed system to the Purchaser's injection point. The compressed (motive) air shall be provided by a regenerative blower mounted on the feeder skid. A motive air stream shall pass through an eductor to draw the PAC into the transport pipeline and transport the PAC pneumatically as a dilute phase mixture to the injection point. The blower and eductor shall be sized such that the operation is virtually dust free.

D. CONTROL

Control of the PAC dosing system shall be through a facility DCS control system located in the facility control room. Seller shall provide the necessary instruments for interlocks, sensors, alarms and trips to protect the system and identify upsets and/or failures. Under normal conditions, operator attention shall not be required.

III. SYSTEM EQUIPMENT

A. PAC STORAGE SILO

1. The bulk storage silo shall be a welded, carbon steel vertical cylinder with a conical bottom and a sloped top. The silo shall be supported by a full height, full diameter structural skirt complete with access doors.
2. Design Loads: Design loads shall include the following loads acting separately or in combination:
    a. Dead weight of the structure.
    b. Weight of powdered activated carbon based on 40 pounds per cubic foot for dead load.
    c. Uniform Building Code or International Building Code, latest edition *(Purchaser to specify)*.
    d. Transportation, handling, and erection loads.

e. Wind load per ASCE 7-98.

f. A live load of 100 pounds per square foot on the silo deck.

g. Wind and dead loads from the silo vent filter.

h. Dead load from the ladders, platforms and ancillary equipment.

3. The silo and anchor bolt system shall be designed by the silo manufacturer for the above noted loads acting separately or in combination.

4. The silo shall be supported by a concrete foundation designed and provided by the Purchaser, based on loads provided by the Silo Manufacturer.

5. Manufacture.

   a. The silo shall be all welded, one-piece construction, fully skirted design, and shall have a cone bottom outlet with a minimum slope of 60 degrees from horizontal. The silo shall be fabricated of carbon steel plate with adequate thickness to withstand the full range of pressure or vacuum to which the silo is to be subjected. Conical bottom plates, the lower skirt (up to the cone) and the roof, shall be no less than 1/4-inch thick. The PAC silo wall above the lower cone shall be no less than 3/16-inch thick. The silo shall include lifting lugs, welded pads for external mounted components and pipe and conduit penetrations as required.

   b. The silo shall include a self-supporting roof with flanged openings for the silo vent filter, the vacuum/pressure relief manway, and the level-monitoring device. The silo roof shall be sloped a minimum of ten (10) degrees to provide adequate drainage.

   c. The silo shall also include the following accessory items:

      i. Structural steel platform in the silo under-skirt area approximately nine (9) feet above the floor for equipment access. The platform shall be fabricated structural members with galvanized grating.

      ii. The silo shall be secured with galvanized (or stainless steel) anchor bolts that pass through the base angle. Anchor bolts shall be designed to withstand both uplift and shear forces.

      iii. Penetrations in silo wall for installation of point level probes to monitor the PAC level in the silo. The silo level switches shall be located such that the devices are readily accessible for maintenance from the ladder or intermediate platform(s).

      iv. A 4” ANSI 150# center top flanged connection for a Ohmart Vega radar type continuous level measurement sensor.

v. A 24-inch minimum diameter pressure and vacuum relief access manhole located in the silo roof. The manhole shall be capable of venting the maximum airflow that will occur in the PAC storage system including the airflow and surge that results when a delivery truck unloads. The manhole shall relieve pressure and vacuum in order to protect the silo. The PRV shall be Knappco model HH or approved equal.

vi. A flanged penetration located on the silo deck for the silo vent filter.

vii. Two (2) fabricated steel access doors. The doors shall be hinged and complete with hardware and shall be flush mounted in the steel channel frame. The access doors shall be provided with a threshold, weather-strip and vent grill.

viii. Access to the top of the silo shall be provided via a vertical, galvanized, OSHA approved steel ladder extending from the base of the silo to the intermediate platform(s) and on to the top of the silo. The ladder shall be equipped with a galvanized steel OSHA approved safety cage.

ix. The silo shall be equipped with handrail and toe plate for the silo roof and platforms. The handrails shall be aluminum pipe and shall meet OSHA standards. The toe plate shall be hot dipped galvanized steel.

x. The silo shall be equipped with penetrations and supports as necessary for installation of conduits and piping to the devices mounted external to the silo. NO cutting and/or welding will be allowed on the silo after delivery.

d. The silo shall be primed with a polyamide epoxy primer over a commercial SSPC SP-6 blast on the exterior surfaces and inside the under-skirt area. The exterior of the silo shall be coated with an acrylic enamel topcoat of a color chosen from the silo manufacturer's standard color chart. The silo top deck will be painted with a Ferrox non-skid coating.

e. Receptacles and Lights: Provide waterproof, ground fault interrupting, duplex convenience outlets mounted on the roof and under the Truck Unloading Panel. Provide eight (8) each incandescent fixtures for mounting in the silo underskirt area. Interior lights shall be EVA-220 as manufactured by Crouse Hinds or equal. Provide exterior high-pressure sodium lights for mounting on top of the silo and at the ladder rest platform. Exterior lights shall be DMVSP150GP as manufactured by Crouse-Hinds or equal. Provide lights switches for the interior and

exterior lights. Light switches shall be EDSC2129 as manufactured by Crouse-Hinds or equal.

B. SILO VENT FILTER

1. The PAC storage silo shall be equipped with a self-contained, open bottomed and flanged cartridge type vent filter mounted to the top of the silo with the following features:

   a. Suitable for the continuous cleaning of the PAC conveying air vented from the storage silo during filling from bulk transport trailers.

   b. Pulse-jet filter and require no more than 7 scfm at 90 psig compressed air for operation.

   c. Contain a minimum of 4 each cartridges with approximately 250 square feet of filtration area.

   d. A pressure differential indicator and high differential pressure switch shall be provided. The differential pressure indicator and switch shall be by Dwyer.

2. The vent filter shall be manufactured by Torit or approved equal.

C. SILO FILL LINE

1. A complete truck fill pipe assembly shall be furnished which will include 4-inch nominal diameter (4½" OD), schedule 40 carbon steel pipe to convey the PAC from delivery truck into the silo. All bends in the fill pipeline shall have a minimum 2'-0" radius. The fill pipe shall start at a point adjacent to the Truck Unloading Panel and shall terminate tangentially approximately one (1) foot below the silo eaves. The piping shall be supported with a suitable number of pipe supports to prevent movement and vibration.

2. The inlet end of the conveying pipe shall be provided with a 4-inch nominal quick disconnect male adapter and dust cap.

D. SILO DISCHARGE VALVE

The PAC storage silo discharge cone shall be equipped with a manually actuated knife gate valve. All wetted parts shall be constructed of 316 stainless steel and the valve shall be equipped with a handwheel operator. The valve shall be manufactured by DeZurik.

E. SILO ROTARY VALVE

The silo discharge cone shall be equipped with a rotary valve for feeding the PAC from the silo into the feeder hopper.

1. The rotary valve shall have a displacement of approximately 60 cubic feet per hour at a speed of approximately 10 rpm. The valve shall be of cast iron construction with ANSI 125 pound, 8-inch flanged inlet and outlet connections. The rotor shall be machined steel with outboard bearings.
2. The design of the valve shall effectively isolate the rotor bearings from the process material. The valve shall be designed for use as a conveying valve.
3. The drive motor shall be a minimum of ½ horsepower, 1,750 rpm, 480 volt, sixty (60) Hertz, three (3) phase, with a 1.15 service factor. The motor shall be TEFC or TENV and meet NEMA standards. The motor shall be manufactured by Baldor, General Electric, Westinghouse, Reliance, or U.S. Motor.
4. The motor shall be coupled to an oil bath lubricated gear reducer mounted on a support bracket extended from the valve body and shall drive the valve rotor through a chain and sprocket arrangement which is encased in an OSHA approved chain guard.
5. The rotary valve shall be Rotolok or approved equal.

F. FEEDER HOPPER

1. A PAC intermediate storage hopper shall be installed between the rotary valve and the volumetric feeder. The hopper shall be fabricated of 304 stainless steel and shall have ample capacity for a product retention time of 20 minutes minimum, but not less than 5 cubic feet. The hopper shall have a side slope minimum of 80 degrees to insure mass flow of the PAC from the hopper. The hopper shall be furnished with a flanged top cover, with an 8” 150# ANSI pattern inlet and a flanged connection to the feeder.
2. The hopper shall be equipped with low level and high level switches to monitor and control the PAC level in the hopper.

G. VOLUMETRIC FEEDER

The feeder shall be of the variable speed control volumetric type utilizing a helical screw. Feeder shall meet the operating requirements as follows:

1. The feeder shall be capable of feeding Powdered Activated Carbon (PAC at 25 pounds per cubic foot) at a rate of *(Purchaser to specify minimum)* to *(Purchaser to specify maximum)* pounds/hour.
2. The feed screw shall be a helical design, constructed of 316 stainless steel and shall discharge the PAC through a stainless steel discharge tube. The screw shall require no mechanical seal. The feeder shall be of stainless steel construction with stainless steel fasteners and fittings. All wetted parts shall be manufactured from stainless steel. All materials and design features shall be suitable for the material being handled.

3. The feeder/feeder drive motor shall be capable of a minimum of a 20:1 “turn down” ratio.
4. The drive motor shall meet NEMA standards, TEFC, and shall be rated for inverter duty. The motor shall be 480 volt/3/60, 1750 RPM with a 1.15 service factor. The motor shall be powered and controlled from the PAC MCC. The motor shall be Baldor, General Electric, Westinghouse, Reliance or U.S. Motor.
5. The feeder discharge shall be equipped with a stainless steel drop tube that will guide the PAC from the feeder discharge tube through a removable silicone rubber hose into the eductor.
6. The feeder shall be manufactured by Acrison, Model 105-Z or BDF as required by the feed rate.

H. PNEUMATIC CONVEYING SYSTEM

1. Motive air shall be provided by a regenerative type blower, as required to transport the maximum PAC requirements at the maximum distance and maximum injection point pressure. The blower shall be manufactured by Siemens, Rotron, or Rietschle.
2. The drop tube between the feeder discharge and the eductor inlet shall be manufactured from 304 stainless steel with a removable silicone rubber connecting hose.
3. The eductor shall be of heat-treated carbon steel construction. The eductor shall be manufactured by Fox Valve Company or approved equal.
4. Rosemount 3051 indicating pressure transmitters shall monitor the blower discharge for high and low alarms and the eductor inlet pressure for high and low alarms.
5. Motive air piping between the blower and the eductor inlet shall be schedule 40 stainless steel threaded. PAC transport piping between the eductor outlet and the system battery limits shall be schedule 80 carbon steel with weld end fittings.

I. COMPRESSED AIR SYSTEM

1. A 60-gallon dry air receiver tank shall be mounted within the silo to stabilize the compressed air pressure for the PAC system. The dry air receiver will be provided with relief valve, automatic moisture drain, alarm pressure switch and pressure indicator. The dry air receiver shall be rated for 200 psig at 100 °F and manufactured by Manchester Tank.
2. Pressure control valves shall be provided as required for proper operation of the subsystems. Air pressure regulators shall be Fisher Model 627.

3. Compressed air piping shall be copper, ASTM B-88, Type K, hard drawn, with comparable solder joint fittings.

4. Fluidizing air tubing between the fluidizing solenoid valves and the fluidizing air nozzles in the silo discharge cone shall be ½" OD 304 stainless steel with Swagelok stainless steel fittings.

J. STRUCTURES & SUPPORTS

1. The PAC feed equipment with associated piping, and instruments shall be mounted on a single support skid(s) fabricated from ASTM A-500 Grade B structural steel members. The structural members shall be of sufficient size to support the equipment without excessive deflection or vibration. Skid, brackets and conduit supports shall be fabricated in accordance with AISC.

2. All external carbon steel surfaces shall be blasted per SSPC SP6 commercial blast to obtain a 1.5 mil average profile.

3. All external carbon steel surfaces shall be painted as described below:

   a. The prime coat shall be Sherwin-Williams Dura-Plate 235 Multi-Purpose Epoxy or equal (4.0 to 8.0 mils DFT).

   b. The finish coat shall be Sherwin-Williams Acrolon 218HS Acrylic Polyurethane or equal (3.0 to 6.0 mil DFT), in "Safety Blue" color.

   c. Touch-up painting, if required, shall be done with Sherwin-Williams Industrial Enamel in "Safety Blue" color.

K. SPARE PARTS

The PAC System Supplier shall provide the following uninstalled spare equipment:

1. One eductor.
2. One point level switch.
3. One 2-way solenoid valve.
4. One set (4) of vent filter cartridges.
5. One Variable Frequency Drive.
6. One feeder drive motor.
7. One feeder auger and gasket.
8. One set (3) blower inlet filters.

IV. CONTROLS

A. CONTROL WIRING PHILOSOPHY

1. The control wiring philosophy shall be such that all field control devices utilize normally closed contacts during normal operating condition.
2. A contact opening or an open circuit shall result in an alarm condition for the specific device.
3. Loss of power to a control device shall result in an alarm condition.

B. TRUCK UNLOADING CONTROL PANEL

A PAC Truck Unloading Control Panel shall be provided to facilitate unloading of bulk PAC transport trailers into the PAC storage silo. The control panel shall contain, lights, terminal blocks, switches, etc. as required and shall be mounted on the silo shell in close proximity to the silo fill pipeline.

C. PANEL FEATURES

The control panel shall be provided with the following items and/or features:

1. Panels shall be constructed of 304 stainless steel and rated NEMA 4X.
2. Terminal blocks shall be provided for termination of all “field run” cables.
3. Terminal blocks for voltage of 120 volts and less shall be equal to Allen Bradley 1492-W10 unless specified otherwise.
4. All selector switches, pilot lights, push buttons and other devices that are visible on the front of the panels shall have Lamacoid nameplates that are white with black letters.
5. Route all wiring in Panduit or similar wireways and separate into categories (i.e., 480 volt power, 120 volt control, etc.). AC or DC power wiring shall not run in any raceway with any type instrument wiring. Protect all wiring across panel hinges. Provide numbered terminal strips for all field-wiring terminations.
6. Wiring shall be stranded copper, 600 volt, MTW or THHN insulated, extra flexible type. Install a minimum of #12 AWG for all power wiring, #16 AWG for all control wiring and #18 AWG twisted shielded pair for analog signal conductors. Color code wires as follows:
   a. Ground wiring shall be green.
   b. 120 volt ac, 480 volt ac and 90 volt dc power wiring shall be black.
   c. Neutral wiring shall be white.
   d. 120 volt ac control wiring shall be red.

e. Any wiring within a cabinet, which cannot be de-energized from within the cabinet shall be yellow.

7. Wiring at all terminals within panels, junction boxes, and field devices shall be numbered with shrink fit, machine printed labels.

E. ELECTRICAL COMPONENTS

1. 120 Volt Circuit Breakers: Allen Bradley 1492-CB,

2. Control Relays: Allen Bradley type HA, Potter Brumfield type KRP or Square D type KP.

3. Selectors and Push buttons: 30.5 mm, heavy duty, NEMA 4X rated; contacts rated 10 amps continuous, 6 amps break at 120 VAC, equal to Allen-Bradley Type 800H.

4. Indicating Lights: 30.5 mm, heavy duty, NEMA 4X rated, 6 volt transformer type, equal to Allen-Bradley Type 800H.

F. CONTROL COMPONENTS.

1. Solenoid valves shall be brass body, soft-seated, with 120V AC solenoid coil. Solenoid operators shall be molded coil in NEMA 4. Maximum operating pressure differential capability shall be 100 psig. Solenoid valves shall not require a minimum pressure to either open or close. Valves shall be two-way or three-way, energize-to-close or energize-to-open as required for the application. Valves shall be ASCO Red Hat or approved equal.

2. The three (3) point level probes for the PAC storage silo level indication and the two (2) point level probes for the feeder hopper level indication shall be oscillating tuning fork type, of stainless steel construction, Bindicator Pulse Point model LP11A1DA30 or equal Endress Hauser.

3. Low air pressure and draft pressure indication and switches shall be Dwyer Photohelic or approved equal.

4. Compressed air pressure switches shall be Ashcroft B series, Square D Class 9012, or Allen Bradley Bulletin 836 or approved equal.

5. The silo vent filter differential pressure switch shall be a Dwyer series 1950.

G. MONITORING DEVICES.

1. An Ohmart VegaPlus radar level-indicating transmitter shall be provided to continuously measure and display the level of PAC in the silo. The unit will be mounted via a flange located at the center of the silo roof. The readout will be located on the DCS HMI. A 4-20mA signal shall be available for remote indication if desired. The unit shall be configured to indicate the distance from the weight up to the surface of the PAC in the silo.

2. The differential pressure across the silo vent filter shall be displayed continuously at the vent filter by a Dwyer Magnihelic Series 2000 differential pressure indicator.

3. Pressure indicators shall be Bourdon tube type with solid front, phenolic plastic case and 4-1/2 inch dial. Indicators shall be Ashcroft Duragauge Style 1279 or approved equal.

H. STATUS & ALARM LIGHTS

1. The following status indications will be displayed on the facility DCS and shall be supported by Seller's instrumentation:

   a. System Start Initiated.

   b. Blower Running.

   c. Air Pressure OK.

   d. Feeder Running.

   e. Rotary Valve Running.

   f. Feeder Hopper Fill Cycle Enabled.

   g. Vent Filter Timer Enabled.

   h. Fluidizing System Operating.

2. The following alarms will be displayed on the facility DCS and shall be supported by Seller's instrumentation:

   a. PAC Silo Level High.

   b. PAC Silo Level Low.

   c. PAC Silo Level Low Low.

   d. Hopper Fill Cycle Malfunction.

   e. Feeder Malfunction.

   f. Blower Discharge Pressure High.

   g. Blower Discharge Pressure Low.

   h. Eductor Suction Pressure High.

   i. Eductor Suction Pressure Low.

   j. Compressed Air Pressure Low.

   k. Silo Filter DP High.

3. The following status lights shall be located on the Truck Unloading Control Panel:
    a. Green - Silo Level Low – OK to Fill.
    b. Green - Vent Filter Sequencing.
4. The following alarm lights shall be located on the Truck Unloading Control Panel:
    a. Amber - Silo Level High - Stop Fill.
    b. Amber - Silo Level Low Low.
    c. Amber - Compressed Air Pressure Low - Stop Fill
    d. Amber - Vent Filter DP High - Stop Fill

J. CONTROL SWITCHES

1. The following control functions will be located on the facility DCS and shall be supported by the Seller's equipment:
    a. Start PAC System pushbutton switch.
    b. Stop PAC System pushbutton switch.
    c. Blower On/Off/Auto selector switch.
    d. Feeder On/Off/Auto selector switch.
    e. Rotary Valve On/Off/Auto selector switch.
    g. Alarm Acknowledge pushbutton switch.
    h. System Mode Non-Paced/Paced selector switch.
    i. High Pressure Fluidization System On/Off/Auto selector switch.
    j. Low Pressure Fluidization System On/Off/Auto selector switch.
2. The following control switches shall be located on the Truck Unloading Panel:
    a. Silo Vent Filter OFF/ON selector switch.
    b. Alarm Acknowledge pushbutton switch.
3. The following control switches shall be located in the silo under-skirt area:
    a. Three (3) each emergency stop pushbutton switches, one at each silo access door and one on the rotary valve elevated platform.

V. SYSTEM OPERATION

The PAC dosing system shall consist of three (3) control loops: (1) silo level monitoring and filling; (2) feeder hopper level monitoring and filling and (3) PAC feed.

A. SILO LEVEL MONITORING AND FILLING.

1. The level of the PAC in the silo shall be monitored continuously by a Radar level detector that will send a signal to the level display located on the facility DCS control display.

2. The PAC level in the storage silo shall also be monitored at three points by “tuning fork” type level switches. When ample volume exists in the silo to accept a complete truckload of PAC (40,000 pounds), the silo low point level switch shall be uncovered by the PAC. The contact opening shall be sensed by the DCS that will activate the PAC SILO LEVEL LOW alarm on the DCS and the SILO LEVEL LOW - OK TO FILL alarm and light on the Truck Unloading Control Panel. If additional PAC is not provided, the silo low low point level switch will be uncovered by the PAC when the level is critically low. The contact opening shall be sensed by the DCS which will activate the PAC SILO LEVEL LOW LOW alarm on the DCS. The silo low low point level switch shall not stop operation of the PAC feed system, which shall operate independently of the PAC level in the silo.

3. The PAC storage silo will be filled by pneumatic road tankers, which will employ a trailer mounted blower to pneumatically transfer the PAC from the tanker into the silo. If the PAC level covers the silo high point level switch the switch shall activate. The DCS shall sense the contact opening and initiate the PAC SILO LEVEL HIGH alarm on the DCS and the SILO LEVEL HIGH - STOP FILL alarm and light on the Truck Unloading Control Panel.

4. During silo filling, the air that is utilized to pneumatically convey the PAC into the silo shall be discharged to the atmosphere through the “cartridge” type silo vent filter. The cartridges shall be sequentially cleaned by pulses of air flowing in the reverse direction through the cartridges on a preset timed basis. Filter operation shall be designated as OFF or ON via a selector switch located on the Truck Unloading Control Panel. In the ON mode, the dust collector shall sequentially pulse clean the cartridges with air on a preset time interval continuously as long as the switch is in the ON position.

5. The VENT FILTER TIMER ENABLED indication located on the DCS Panel and light located on the Truck Unloading Control Panel shall be illuminated when the vent filter timer board is energized.

6. The differential pressure across the vent filter cartridges shall be monitored continuously by a locally mounted differential pressure switch. The switch shall activate on a differential pressure of 3 to 4 inches of water pressure across the bags. The DCS will sense a contact opening on high differential pressure and initiate an alarm if the differential pressure remains high for a pre-set period of time (usually 20 seconds).

B. FEEDER HOPPER LEVEL MONITORING AND FILLING.

1. The level in the volumetric feeder supply hopper shall be monitored by level switches to maintain a constant level in the hopper. When the high level probe is uncovered, a signal shall be sent to the DCS and a hopper filling sequence shall be initiated after a pre-determined amount of time, if the fluidization cycle selector switch and the rotary valve selector switch are both in the AUTO position.

2. When the rotary valve begins operation to refill the hopper, the low pressure air fluidization cycle shall be initiated. Provided that AUTO LP fluidization has been selected, the LP fluidization solenoid valve shall pulse open for a predetermined amount of time to provide fluidization air to the storage silo PAC outlet cone. Additionally, selecting the MANUAL LP fluidize function on the DCS shall provide a single fluidization pulse to the outlet cone.

3. When the fill cycle is initiated FEEDER HOPPER FILL CYCLE INITIATED indication, the FLUIDIZING SYSTEM OPERATING indication and the ROTARY VALVE RUNNING indication shall be displayed on the DCS.

4. The hopper filling sequence shall stop when the high level probe has been covered with PAC.

5. If the hopper low level switch is uncovered, a feeder hopper fill malfunction alarm shall be initiated. Additionally, the time required to cover the hopper high level switch, after the fill cycle has been initiated, shall be monitored and if the elapsed time exceeds a pre-determined time, a feeder hopper fill malfunction alarm shall be initiated. A feeder hopper fill malfunction alarm shall terminate operation of the feeder, until the alarm is cleared.

6. The HP fluidization solenoids shall be pulsed on a timed basis, provided the feeder is operating, when the HP AUTO function has been selected. Additionally, selecting the MANUAL HP fluidize function on the DCS shall provide a single HP fluidization cycle to the upper portion of the outlet cone.

C. PAC FEED.

1. Depressing the PAC SYSTEM START pushbutton on the DCS shall initiate the automatic start sequence and display SYSTEM START INITIATED indication on the DCS HMI.

2. The SYSTEM START shall initiate operation of the blower.

3. After the blower discharge pressure and the eductor suction pressure have been established by pressure switches, the AIR PRESSURE ESTABLISHED indication on the DCS HMI shall be displayed. The system controls shall allow ten (10) seconds for motive and eductor suction pressures to be established, otherwise the high or low blower discharge pressure alarm or the high or low eductor inlet pressure alarm shall be initiated and the feeder shall not start until the problem is resolved and the alarm is cleared.

4. Thirty (30) seconds after blower discharge (motive air) pressure and eductor suction pressures have been established, the volumetric feeder shall begin feeding PAC into the drop tube and eductor. The FEEDER RUNNING indication on the DCS HMI shall be displayed.

5. With the SYSTEM MODE selector in NON-PACED mode, the operator shall manually set a fixed PAC feed rate in pounds per hour via the feeder control screen on the DCS HMI. The feed rate in pounds per hour shall be displayed on the DCS HMI.

6. With the SYSTEM MODE selector in PACED mode, the feeder shall maintain a constant dosing rate in pounds per hour per megawatt or other parameter (such as mmcfm of gas flow). The dosing rate shall be operator settable from the DCS HMI.

7. If the feeder motor drive variable frequency drive faults or fails to start, a FEEDER MALFUNCTION alarm shall be initiated and the feeder shall be stopped.

8. The system shall provide PAC to the system until stopped by selecting the local PAC System STOP on the DCS. System STOP shall immediately terminate operation of the feeder and thirty (30) seconds later stop the blower, thereby, terminating system operation.

9. Restart of the system after a manual shutdown shall be accomplished by selecting local PAC SYSTEM START on the DCS HMI. Restart of the system after a system trip and all alarms have been cleared shall be accomplished in the same manner.

D. CALIBRATION.

1. The PAC dosing system shall provide the means for calibration of the feeder on a regular basis. The Operator shall physically “catch” a weight sample over a timed period at a known feeder rpm, weigh the sample, calculate the actual pounds per hour at the maximum rpm and enter the feed rate into the system controls.

2. When the calculated feed rate is entered, the control system shall make the necessary adjustments to conform the controls and displays to the new calibrated feed rate.

E. ALARMS.

The alarm sequence shall operate essentially the same for all alarms. When an alarm is initiated, the alarm horn will sound until the alarm is acknowledged by pressing the designated acknowledge button on the DCS HMI. When the alarm acknowledge button is pressed, the alarm horn will be silenced. The alarm will remain active until cleared. For critical alarms, system operation shall be "locked out" until the alarm is cleared and reset via the DCS HMI. The following alarms shall be provided:

1. Silo Level High (Do Not Fill) - A silo level high alarm shall activate on the PAC Control Panel and on the Truck Unloading Panel when the silo is full and filling operations should be terminated. This alarm shall not have any effect on the filling operations or normal system operation, other than to provide an alarm, and shall automatically clear once the PAC level in the silo has fallen below the high point level probe.

2. Silo Level Low (OK To Fill) - A silo level low alarm shall activate on the PAC Control Panel and on the Truck Unloading Panel when the PAC level in the storage silo has fallen below the low point level probe. The silo low level alarm shall indicate sufficient volume in the silo to receive a bulk trailer load of PAC. This alarm shall not have any effect on normal system operation, other than to provide an alarm, and shall automatically clear once the PAC level in the silo has covered the low point level probe.

3. Silo Level Low Low - A silo level low low alarm shall be activated on the PAC Control Panel when the PAC level in the storage silo falls below the low low point level probe and indicates that the PAC level is critically low. This alarm shall not have any effect on normal system operation, other than to provide an alarm, and shall automatically clear once the PAC level in the silo has covered the low low point level probe

4. Motive Air Pressure Low - A low motive air pressure alarm shall be initiated when the blower discharge pressure falls below a pre-set value. Operation of the feeder and blower shall be stopped when the alarm is initiated. The alarm must be acknowledged and reset prior to restarting the system.

5. Motive Air Pressure High - A high motive air pressure alarm shall be initiated when the blower discharge pressure exceeds a pre-set value. Operation of the feeder and blower shall be stopped when the alarm is initiated. The alarm must be acknowledged and reset prior to restarting the system.

6. Eductor Inlet Pressure Low – A low eductor inlet air pressure alarm shall be initiated when the eductor inlet (drop tube) pressure falls below a pre-set value. Operation of the feeder and blower shall be stopped when the alarm is initiated. The alarm must be acknowledged and reset prior to restarting the system.

7. Eductor Inlet Pressure High - A high eductor inlet air pressure alarm shall be initiated when the eductor inlet (drop tube) pressure rises above a pre-set value. Operation of the feeder and blower shall be stopped when the alarm is initiated. The alarm must be acknowledged and reset prior to restarting the system.

8. Feeder Hopper Fill Malfunction - The feeder hopper fill malfunction alarm shall be initiated if the time to cover the hopper high level probe, after the rotary valve has been given a start signal, exceeds one (1) minute or if the feeder hopper low level probe is uncovered. The feeder hopper fill malfunction alarm shall stop operation of the feeder, the rotary valve and the fluidization system until the alarm is cleared. The alarm must be acknowledged and reset prior to restarting the system.

9. Feeder Malfunction - A feeder malfunction alarm shall be initiated if the VFD is faulted. The alarm must be acknowledged and reset prior to restarting the system.

10. Silo Vent Filter DP High - The differential pressure across the vent filter bags shall be monitored at all times by a differential pressure switch mounted on the silo deck. If the high differential pressure switch remains in the high differential state for a period of fifteen (15) seconds, the silo vent filter DP high alarm shall be initiated. This alarm shall not effect the filling operation or normal system operation and shall automatically clear when the differential pressure returns to normal.

11. Compressed Air Pressure Low - The air system pressure shall be monitored continuously by a pressure switch mounted on the compressed air piping. The compressed air pressure low alarm shall be initiated when the air pressure has fallen below a pre-set pressure (80 psig).

VI. FIELD INSTALLATION

A. INSTALLATION

1. The Installation Contractor shall perform the final field assembly, field wiring, field piping and adjustments necessary to provide a complete operating system.

2. The Installation Contractor shall perform all fieldwork in accordance with the requirements of these Specifications and the drawing prepared by the PAC System Supplier.

B. FIELD PAINTING

1. Any equipment not shop painted shall be field painted by the Installation Contractor in accordance with these Specifications.

2. The Installation Contractor shall perform touch-up painting of all equipment as required to provide a protective coating in accordance with these Specifications.

C. CLEAN UP

Prior to acceptance of the Work, the Installation Contractor shall thoroughly clean all installed materials, equipment and related areas in accordance with these Specifications.

VII. OPTIONS

A. LOCAL CONTROL

1. A stand-alone control system shall be provided to control the sequences of events throughout the system and also provide alarms to enunciate problems and interlocks to protect the system.

2. The PAC system controls shall be contained within a PAC Control Panel, including HMI, PLC, power supplies, control relays, lights, terminal blocks, switches, etc. The complete PAC feed system shall be controlled from the PAC Control Panel and/or the Truck Unloading Panel. The control panel shall conform to the requirements herein.

3. Control of the PAC dosing system shall be via a Human Machine Interface (HMI) located on the front of a locally mounted PAC System Control Panel. The HMI will have a color monitor with keypad and will provide ample screens for easy control of the system. The HMI shall be an Allen Bradley PanelView Plus 1000 or approved equal.

4. A programmable logic controller (PLC) shall control the sequence of events throughout the system. Complete software documentation including a ladder logic diagram printout with a complete set of comments and a narrative description of the sequence of operation shall be provided. The PLC shall be an Allen-Bradley, Model CompactLogix or ControlLogix.

B. CONTROL BUILDING

1. Provide a pre-cast concrete building to house the MCC, the control power transformer, the PAC Control Panel, the air compressor, the air drier and filters, and the dry air accumulator.

2. The building shall be approximately 12’ L (outside) x 8’ W (outside) x 9’ H (inside). The building shall have a single (1) access door measuring 3’-0” W x 6’-8”.

3. The building shall be equipped with a built-in air conditioner and heater to maintain the environment in the building.
4. The exterior finish of the building shall be an exposed aggregate finish with a waterproof sealer.
5. The interior finish of the building shall be a smooth steel form finish. Walls and ceiling shall be painted with a white, two-part, waterborne Epoxy Polyamide paint (TUR-GLAZE-WB 4408) as manufactured by DEVOE Coatings.
6. The building will arrive on site with all internal equipment installed, piped and wired to the greatest extent practical.
7. Building engineering design and calculations shall be sealed by a Professional Engineer in the State of Manufacture.

C. COMPRESSED AIR SYSTEM

1. Provide a complete stand-alone compressed air system capable of providing and storing the quantity and quality of compressed air necessary to sustain operation of the PAC dosing system (minimum 10 scfm). The system shall include compressor, air receiver, refrigeration air dryer and filters, automatic drain valves and a dry air accumulator.
2. The compressor and drive motor shall be mounted on the air receiver. The compressor shall be belt driven with an OSHA approved guard. The air receiver shall have a minimum volume of 60 gallons, a minimum ASME rating for 150 psig, and shall be complete with drains, vents, pressure gauge, and pressure switch. The compressor shall be Quincy, Champion, Ingersoll-Rand or approved equal.
3. The drive motor shall be 480 volts AC, 3-phase, 5 horsepower minimum, Baldor Super-E Premium Efficiency or approved equal.
4. The air drier shall be a non-cycling, refrigeration type drier capable of reducing the dew point of the maximum air requirements at 100 °F and 100 psig to 38 °F with an ambient temperature of 100 °F. The air drier shall be manufactured by Pneumatech, Zeks or approved equal.

D. POWER DISTRIBUTION

1. Provide a PAC system 480 Motor Control Center (MCC) which shall contain a main disconnect breaker, motor circuit breakers, motor starters, power blocks, terminal blocks, breakers, fuses and control power transformer.
2. A main disconnect breaker shall be provided to de-energize the MCC and the complete PAC electrical system.
3. Motor circuit protectors, NEMA starters and overload protection shall be provided for each 480-volt AC motor.

4. A 480-volt AC single phase (3-phase if required) to 120 volt AC single phase (3-phase 208/120 if required) transformer shall provide 120-volt AC power for control and equipment.
5. A single breaker (3 pole 208/120 or single pole 120) shall be provided for isolation and protection of the control power system. Individual single-phase breakers shall be provided as required for distribution of 120 volt AC power.
6. The MCC shall be an Allen Bradley Centerline Bulletin 2100 or approved equal.

E. SILO STAIRS

1. Provide stairs and platforms on the exterior of PAC storage silo for access to the intermediate platform inside the silo skirt and to the silo roof.
2. The stairs shall meet OSHA standards and shall be hot dipped galvanized with galvanized abrasive noseing. Handrails shall be standard diameter HDG. Stairs shall be 36 inches wide.
3. Stairs shall be provided with intermediate platform for access to the platform located above the feeders.

F. PRE-ASSEMBLY

1. The PAC storage and dosing system shall be assembled to the greatest extent practical prior to shipment to the site. Seller shall install a structural floor in the silo under-skirt area and shall install all equipment in the silo under-skirt area, including but not limited to feeder skids, rotary valves, fluidizing air system, valves and piping, conduit and wiring, and junction boxes as required.

G. INSTALLATION

1. Seller shall provide on-site installation, check-out, start-up and performance testing of the PAC storage and dosing system.
2. Seller shall provide all equipment and incidentals necessary for a complete operational system.

END OF SECTION